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/SUMMARY/

A HIGH PRODUCTIVITY SHOP

/Production of Ball Bearings/

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The low productivity of labor in the ball-bearing shop of the 1GPZ (First State Bearing Plant imeni L. M. Kaganovich) greatly retarded the work of the entire plant in recent years.

Despite the fact that this shop, in volume of work, is not inferior even to the greatest ball-bearing plants of the US, problems of technology and organization of production needed basic improvement. Such a situation was the result of procuring equipment from different and often casual sources. Furthermore the technological process used in the shop had become obsolete.

This situation was largely due to the fact that a high regard for foreign work had been developed and domestic production had been neglected. The technological processes of foreign firms were blindly copied. The fact that foreign firms permitted familiarization only with outdated technologies and did not divulge secret production processes was not considered. Finally there was insufficient use of the potentialities of socialistic method of production, of the creative ability of our workers and engineer-technicians, and of the attainments of our Soviet science. The inadequate state of calculation and planning was also overlooked.

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In connection with this problem, the Chair of Technology of Machine Building, MVTU (Moscow Higher Technical School), conducted during the second half of 1945 and the first half of 1946, a series of tests on the basis of which concrete measures were recommended for improving the technology of ball-bearings production. These tests were carried out at the request of the plant and with the aid of the Physicochemical Institute, Academy of Sciences USSR, and the ENIIPP (Scientific Research and Experimental Institute of the Bearing Industry). The new technology developed under the guidance of Professor V. M. Kovan, Doctor of Technical Sciences, head of the Chair of Machine Building Technology, MVTU, was an attempt to establish the Soviet technology of the ball-bearing industry. The new technology was based on the achievements in two fields of Soviet science: the technology of machine building and chemical engineering. In these fields, Soviet science, in the past 10 years and especially in the postwar period, has assumed leadership, blazing new trails and outstripping other countries.

The methods for making ball bearings, in our country as well as in others, were examined. All measures, necessary for establishing the new technology, were divided into two groups. The first group included those which could be introduced into the existing conditions. The second group included those measures which were connected with capital outlays or with serious demands on other branches of the industry. Such measures were: increasing the diameter of polishing discs from 600 to 800 and 1,000 millimeters; an immediate improvement of the quality of cast-iron discs and pastes for lapping; decreasing the hardness of the metal; substitution of coil for rod steel; increasing the hardness of the ball bearings; building machines of new and original design; complete automechanization of the technological and control processes; improving the automatic feed of the machines; and electroheating of the metal in rolling and hot forging.

Instead of making new machinery, a broad but not very complex modernization of the equipment was proposed. It included: (1) the improvement of the automatic machine feeds by replacing the low-capacity feeders, mounted in the base of the machines, with large-capacity feeders; (2) the conversion of lapping machines, which had lost the accuracy needed in present operations, for use in rough operations. Thus, with a minimum outlay with the simplest constructional changes, polishing and filing machines were created and named "1GPZ machines."

The 1GPZ polishing and filing machines were made from lapping machines which were no longer useful in their original functions, and which could better be used as models for ball-bearing filing and polishing machines that gave high-quality work and high productivity. This simple modernization gave exceptionally positive results; it assured the possibility of easily increasing the capacity of a series of operations which previously had slowed up the work of the shop, and in turn had lowered its general efficiency.

Furthermore, the different groups of ball bearings were fixed according to definite types of machines with the purpose of assuring the most efficient system which would guarantee better quality and maximum productivity. Consequently, arbitrariness and casualness in the work was eliminated and, by computing all the possibilities of the machines, it was determined on what size and model machines the ball bearings should be made.

The old argument on the advantages of filing or polishing first was solved by experimenting. It was decided to process the balls as follows: Small-, medium-, and some of the large-size balls, i.e., the basic group of the mass types, 1/16-1 inch, to be filed; balls, 1-1 1/8 inches, to be either filed or polished; and balls, above 1 1/8 inches, to be polished first.

Under the old system, ball bearings of all sizes were filed on horizontal-filing flat machines containing two discs, one of which was grooved. Under the

new system, small balls, up to 3/16 inch inclusive, are filed on the 1GPZ vertical-filing machines between 330-millimeter diameter flat-filing discs having cogs that are milled in a dendritic pattern (Figure 1).

Ball bearings, 7/32-13/32 inch inclusive, are processed on FKF horizontal-filing machines with two hoppers, two pairs of discs, and with a greater feeding capacity. The 315-millimeter diameter discs are flat, and have straight cogs (Figure 2).

Ball bearings, 7/16-23/32 inch inclusive, are filed on the Shiss horizontal-filing machines having a separate high-capacity feeder and two sectionally located, 715-millimeter diameter flat-filing discs (Figure 3).

Ball bearings, 3/4-1 inch inclusive, are processed on Fiat horizontal-filing machines, on of whose filing discs is grooved, or on 1GPZ vertical-filing machines (second model) with two flat-filing discs (Figure 4).

Ball bearings of a diameter larger than 1 inch are processed on the 1GPZ second-model vertical-filing machines (Figure 5). However, for ball bearings larger than 1 1/8 inch, polishing first on the machine shown in Figure 6 is recommended.

The above changes in the technological processes, based on the rational application of various machines and filing discs, successfully increased the productivity and improved the quality of the ball bearings. An increase in productivity also meant a decrease in the allowable tolerances and an improvement of the geometric form of the stamped stock.

All ball bearings were divided into five groups corresponding to the above-mentioned sizes. For Group I, the allowable deviation of the diameter of the stamped ball was established at 0.05 instead of 0.10 millimeter in the old method; Group II, 0.06 instead of 0.12 millimeter; Group III, 0.08 instead of 0.12 millimeter; Group IV, 0.10 - 0.12 - 0.15 instead of 0.15 millimeter; Group V, 0.16 instead of 0.20 millimeter.

The height of the polar projections was decreased by one half, and the thickness and width of the seam (Saturn ring) by 25 percent. The tolerance on the dimensions was cut by one half.

After the ball bearings of Group II are filed, they must be submitted to a smoothing or soft polishing before they are subjected to the abrasive process in the sanders. This operation is also recommended for the other ball bearings.

The new abrasive process differs from the old in the application of a weak solution of nitrous acid or copper sulfate, by using hot water instead of cold, and by using modernized sanders and new-type basins. The possibility of working with emery in a basin of mineral oil was also examined as a parallel process.

It should be noted that both these variants of the abrasive process were tested in the ball-bearing shop of the 1GPZ in 1939.

After the abrasive process and the subsequent polishing, there follows the lapping of the coarse balls with emery between 1,000-millimeter diameter discs on 1GPZ model machines, converted from Oberling horizontal machines.

In processing the hardened balls, a measure was introduced which, distinguished by its simplicity, broke all records of the ball-bearing industry. In order to increase the productivity, to moderate the deficiencies of the polishing wheels and to employ the equipment effectively, it was decided to discard the hitherto accepted combined operation of polishing the hardened balls (so-called rough polishing) and correcting the ovalness. Correcting the ovalness

was moved to the next stage--lapping. Consequently there was a corresponding increase in production at this stage.

The final lapping of the balls to a greater precision is done on Kugel-Fisher vertical-finishing machines in no larger than 25-kilogram groups. In this manner, there is attained an ovalness of no greater than 0.5 (it was formerly 1), and with more careful work, below 0.3 (it was below 0.5), i.e., practically with zero ovalness.

With certain additional work, balls of ultrahigh precision, known as "Pribornyye," were produced. Lapping produces a very high-quality surface; however, it can be completely replaced by special honing processes, and with the use of special pastes (for example, aluminum oxides) ball bearings which greatly surpass the ultrahigh-precision bearings can be made.

However, the problem of maintenance of equipment and the simplification of the operation require honing by French chalk and subsequent honing with leather.

In the old system, in all ball-filing and polishing machines, kerosene was used as a spraying (cutting) fluid. The use of kerosene caused occupational diseases and fire hazards. Substitution of a liquid solution of an alkaline phosphate in place of kerosene in the filing machines, and a solar oil in polishing machines, improved health conditions and eliminated fire hazards. In this project, the works of Academician P. A. Rebinder were used.

Despite the indisputable ease and usefulness of the new technology, its introduction was extraordinarily slow. This was explained by the low levels of technology and industrial labor discipline, and the absence of unified management in the shop

In November 1946, the director of the 1GPZ plant invited Baykov to inspect the shop. Baykov agreed with the decision of the MVTU, and was appointed head of the 1GPZ ball shop, where he worked for about a year.

First of all, it was necessary to establish an elementary training course in the shop, and increase the activity of the shop personnel. The system of personal demonstrations was widely used. The introduction of each principal innovation was accompanied by a detailed explanation, why it was needed, what it did, and how to use it. All workers' questions were answered.

Reports of the results of the work were disseminated to all workers. Not only the supervisors and the foremen, but also the technicians, constructors, planners, economists, mechanics, electricians, and accountants, were regularly given an account of their work.

Problems of calculation and planning occupied an important position in the industrial activity of the shop.

The entire personnel of the shop was the first in the plant to be entered, in November 1946, in the socialist competition in honor of the 30th Anniversary of the Great October Socialist Revolution; and the shop assumed a corresponding socialist obligation. The shop prodedure became one of socialist collaboration and Stakhanovite labor in all professions.

Much attention was devoted to problems of maintenance and operation of the equipment. Maintenance brigades of machinists were formed in each department. The technical assistant to the shop supervisor was relieved of all his duties and put in charge of all matters pertaining to maintenance and operation of equipment. Due to the introduction of presses in a serviceable condition in the stamping department, the output was trebled. The production superintendent of the shop was given much greater authority.

The shop supervisor was given the duty of solving all principal problems. He was also made supervisor of the technical part of the shop, the technological bureau of the ball-bearing production of the plant, and the combined modernization and maintenance brigades of the 1GPZ and the ENIIPP. At the same time, the authorities of the assistants of the shop supervisor and the foremen actually in charge of production were greatly expanded.

Technical study was also regulated to assure a wide dissemination of the leading Stakhanovite practices.

Great emphasis was also placed on the discussions between the shop supervisor and each shop worker at the place of work even if only once a month. A daily survey of the entire shop and all maintenance sections by the supervisor was instituted.

For adjusting specific operations, workers from the laboratories and plant-management departments were used, as well as from the ENIIPP.

Plant workers were enlisted in aiding the shop by being included in a plant-modernization brigade.

ENIIPP workers were brought in to render technical aid participating in the joint 1GPZ and ENIIPP brigade, which was headed by the supervisors of both groups. The supervisors represented the 1GPZ plant director and S.N. Simagin, the director of the ENIIPP, respectively.

All these measures and assistance from the plant supervisors -- V. N. Takhtarov, the plant director; A. A. Gromov, chief engineer; N. A. Arutyunov, chief of production; R. A. Pevzner, chief technician; D. I. Mikhaylov, chief mechanic; I. N. Golov, chief of the OKS; M. V. Korobov, chief of Glavpodshipnik (Main Administration of the Ball-Bearing Industry); V. K. Devyatov, chief engineer; S. V. Pinegin, Doctor of Technical Sciences, the director of the ENIIPP -- with the support of party and trade-union organizations, made it possible to introduce the new technology within 5 months. In April 1947, the ball-bearing shop of the 1GPZ was already operating under the new technology.

In December 1946, the shop had begun to fulfill the daily quotes. There was a sudden increase in gross and commodity output of balls for bearings, and of loose balls. The production of one worker grew from 1,909 rubles in November 1946 to 10,324 rubles in October 1947. The gross production output per one square meter of area for the same period increased from 46 rubles to 277 rubles, and the gross production output for a single unit of equipment, taken on the average for the shop, grew from 1,457 to 5,417 rubles.

Technical and economic indexes of 1940 were again reached in February 1947, after which they were significantly surpassed. In October, they had reached a level set by the plan for 1950. By the same time, the shop had completed its plan for 1947, and for the sixth time had won the transferable Order of the Red Banner of Labor, and first place in the socialist competition among the shops of the plant. In the first 10 months of 1947, the shop had cut expenses by 3.5 million rubles. In October, for the work completed by the ball-bearing shop, the plant was awarded a first prize of 100,000 rubles by a decision of the Soviet of Ministers USSR.

All these results show that the ball-bearing shop of 1GPZ is a high productivity shop, and speak for the great production possibilities which the new technology uncovers.

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